Focus: New discussions in Europe on animal experiments focus on the issue of using primates. (Photo: Koehler Primate Research Centre; http://wkprc.eva.mpg.de at MPI-EVA.)

primates in research. Many primates face extinction, they argued, as a result of increased habitat destruction and eating their flesh, known as bushmeat. "It may be difficult to protect primates from these threats if it is perceived these species are used freely by Western academic institutions," the MEPs warned. But this declaration was rejected by the European Commission in drawing up its new directive, although many researchers fear that the European Parliament will seek to change the proposals.

"We are dismayed that some members of the European parliament are burying their heads in the sands of anti-vivisection propaganda, refusing to even meet researchers or visit animal facilities," said Simon Festing, director of the Research Defence Society in the UK.

"I do despair of the constant battles we have to fight just to continue to do good science and save lives. These waves of anti-science we keep experiencing are disquieting," said neuroscientist Tipu Aziz of Oxford University.

"Modern biology is hugely dependent on the use of animals in research. Not only has the use of animals in research contributed to our understanding of how the human body works and the development of treatments and medicines that reduce human suffering and save lives, but it is also vital to progress in veterinary medicine," says Britain's science academy, the Royal Society. "It is important the directive balances benefits to humans with animal welfare for the greater good of both. As a means of achieving that balance the Society strongly endorses the principle of the 3Rs to reduce, refine and replace the use of animals in research where possible."

Q & A

Marla Sokolowski

Marla B. Sokolowski is a Professor and a Canada Research Chair in Genetics and Neurology at University of Toronto. Her B.Sc. (1977) and Ph.D. (1981) were from the Department of Zoology, University of Toronto. She was an Assistant Professor and NSERC University Research Fellow at York University in Toronto from 1982–1999. Her discovery and investigations of the rover/sitter polymorphism in the Drosophila foraging *gene facilitated a new sub-discipline of behavioural genetics, one that explores the mechanistic and evolutionary significance of naturally occurring behavioural variation. She was elected a Fellow of the Royal Society of Canada in 1998 and co-directs the Experience-based Brain and Biological Development Group of the Canadian Institutes for Advanced Research.*

What is your background and how did it facilitate your becoming a scientist? Neither of my parents had the opportunity, nor the means, to attend University. My father was a Holocaust survivor who settled in Canada after the Second World War. He operated a shoe store in an economically depressed part of Toronto for most of his working life. Newcomers to Toronto as well as long-time Canadians came to the store to buy shoes and chat with my father about their lives and he shared his life story with his customers. He also spoke to school children about his life in Hungary and how quickly certain groups were dehumanized. He believed that people's racism, anti-Semitism or sexism could be changed 'one person at a time' by getting to know one another and sharing our stories. My mother was born in Canada during the depression and taught young children. Both of my parents were self-educated, very well read and loved to discuss ideas. My parents worked hard to enable my brothers and me to go to university and believed that education would open many doors for us that were closed to them. I was born in the mid-1950s when few women had careers. As a young girl, I liked to play and collect things in the nearby creek. Playing school was among my favourite childhood

activities. In high school, I loved physics and math. I always felt that I would do something different.

What is your scientific pedigree? I do not really have one. After my undergraduate degree, I was accepted into the PhD program at University of Toronto and started to do *Drosophila* behavioural genetics in a mathematical ecology lab run by Roger Hansell, where everyone else did purely theoretical biology. I joined the group because I was allowed to do what I wanted, which greatly appealed to me. I knew I wanted to study genes and behaviour. I think that in some ways my research has benefited from my lack of pedigree because I was able to develop and follow my own path. But much of my success in research has also depended on the wisdom of exceptional collaborators.

You became interested in genes and behaviour at a time when few biologists considered behaviour to be amenable to genetic analysis — how did this happen? In 1975, I took a course in animal behaviour. This course had a formative and lasting effect on my research career. The assigned text book was *An Introduction to Animal Behaviour* by Aubrey Manning. His book made me look at the animal world differently. My first recollection of this was watching gulls exhibit their territorial displays in a parking lot of a fast-food restaurant. The course had a lab component where we tested the locomotion of different mouse strains in an open field assay and I soon realized that different strains of mice behaved quite differently in this assay, as if they had different 'personalities'. I loved the challenge of trying to understand behaviour and, as a matter of fact, it was precisely the complexity of these phenotypes that attracted me.

Genetics also appealed to me because it made sense. You didn't have to memorize facts and it felt to me at the time that there were no black boxes in genetics. Little did I know! So with these separate interests in behaviour and genetics in 1976 I took a course in developmental genetics given by Ellen Larson at University of Toronto. The course involved a research project on *Drosophila*. I wanted to do a genetic analysis of behaviour but was heavily discouraged because the course focused on development. I persisted by suggesting that I could study larvae because they are developing. I made a tiny open-field assay for the larvae as was done for mice and this time using a microscope, I watched the larvae move, both on and off their food, found the first rover and sitter foragers and performed a genetic analysis of this behavioural difference. Little did I know that this student project provided the beginnings of what my colleagues and I would study for the next 30 years. Today we know that the rover/sitter behaviour arises from natural variation at the *foraging* gene which encodes a cGMP-dependent protein kinase important for food-related behaviours in many organisms.

What papers, people or experiences inspired your work? I was inspired by both positive and negative experiences. First, some positive influences. As a student, my research was focused on normal individual differences in behaviour, rather than mutant effects, because my interests arose from an evolutionary, not a mechanistic perspective. At the time I began my research, Richard Lewontin was speaking out against the circularity of selectionist arguments which I too had found unsatisfying. In Lewontin's 1970s papers he stated that we need to demonstrate three things before we can call a trait adaptive: first, that the trait exhibited phenotypic variation; second, that this variation had a heritable component; and third, that these heritable differences had fitness consequences. This inspired my early research program. At a more personal level, two other people affected my early research. Douglas Wahlsten opened my eyes to the importance of gene-by-environment interactions and genetic background, both of which were unappreciated by most geneticists in the 1980s. And of course, the infamous Jeff Hall, whose insightfulness, knowledge and generosity is unsurpassed, was a great influence.

Now to the negative. My early research was criticized and trivialized by many. This was not done at a personal level; it was simply a sign of the times. Some examples: geneticists thought that behaviour was not a phenotype amenable to genetic analysis because it is far too variable and unpredictable to quantify. Ecologists thought that work on *Drosophila* behaviour and its evolutionary implications was uninteresting because it had no relevance to nature. Evolutionary biologists thought the rover/sitter story was a rare example of a major gene trait but that in reality all genes that affect complex traits must have small equal and additive effects and therefore, by definition, could not be localized in the genome. Many considered the rover/sitter polymorphism a cute exception. I could go on. My response to such criticism was to dig in, learn more about the system, and ultimately, hopefully, to disprove the criticism.

You are a successful scientist and also a parent — how do you balance your home and professional lives? It is a balancing act, and one that seems to change every day as my children grow and their needs change; however, I have a lot of support. In fact, I often feel that I have two families. In my primary family, at home, I have two great teenage children and a husband of 33 years who carries more than 50% of the home workload. My secondary family consists of the myriad people in my laboratory, who fill in for me when my kids are sick or need me at home, and my husband and kids hold things together at home when I am travelling for work or have a major grant due.

What is the most difficult part of your job? The pressure of having to write grants to keep valued and highly skilled people in the laboratory over the long term is always challenging. But such pressure does ensure that I must continually think creatively and clearly about my research programme. It helps to keep my research current and fresh.

What do you like most about being a scientist? My career in research brings me a great deal of pleasure. One of the biggest pleasures is mentoring and nurturing young scientists and watching them develop and flourish. I feel very happy to know that I have influenced some of my students' lives in a positive direction. Another huge pleasure is the privilege of living in a world of exciting ideas and questions and sharing and collaborating. I'll never get bored with a job that allows me the freedom to pursue my intellectual dreams. I also really love to learn new things and the field of genes and behaviour has required constant retraining. I find this very challenging and exciting.

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